(2) What is the theoretical yield?

(3) What is the percent yield? **(E22)**

SELF-TEST

A. Multiple choice:

1. Copper(II) oxide reacts with hydrogen gas, producing copper metal and water. The correct form of the chemical equation that describes this reaction is
   a. $Cu_2O\ (s) + H_2\ (g) \rightarrow 2\,Cu\ (s) + H_2O\ (\ell)$
   b. $Cu_2O\ (s) + 2\,H\ (g) \rightarrow 2\,Cu\ (s) + H_2O\ (\ell)$
   c. $CuO\ (s) + H_2\ (g) \rightarrow Cu\ (s) + H_2O\ (\ell)$
   d. $CuO\ (s) + 2\,H\ (g) \rightarrow Cu\ (s) + H_2O\ (\ell)$
   e. None of the above equations is correct.

2. The units for Avogadro's number can be
   a. molecules per mole. **b.** atoms per mole.
   c. ions per mole. **d.** all of the above.

3. How many kg of copper could one theoretically obtain from one kilogram of copper fluorosilicate, Cu_2SiF_6 ($\mathcal{M}$ = 269.1 g/mol)?
   a. 2(63.5)/1000 **b.** 2(63.5)(269.1) **c.** 2(63.5)/269.1
   d. 2(63.5)(269.1)/1000 **e.** 2(63.5)(1000)/269.1

4. The atomic mass of vanadium is 50.942. Vanadium consists of two isotopes: $^{50}_{23}V$, mass 49.947 and $^{51}_{23}V$, mass 50.944. From this we can conclude that the abundance of $^{51}_{23}V$ is
   a. about 10%　　b. about 33%　　c. about 66%　　d. about 99%

5. Which one of the following particles has a mass that is closest to the mass of the oxygen atom?
   a. F atom　　b. OH^- ion　　c. O^{2-} ion　　d. H_2O molecule

6. The number of molecules in a sample of NH_3 weighing 8.50 g is
   a. 0.500　　b. 1.00　　c. 144　　d. 3.01×10^{23}　　e. 6.02×10^{23}

7. A compound contains 29.3% C, 57.7% Cl and 13.0% O by mass. Its molar mass is 246 g/mol. Its molecular formula is: (All choices have $\mathcal{M}$ = 246 g/mol)
   a. $C_6Cl_4O_2$　　b. $C_3Cl_5O_2$　　c. $C_2Cl_4O_5$　　d. $C_9Cl_3O_2$

8. Which of the following statements about caffeine, $C_8H_{10}O_2N_4$ ($\mathcal{M}$ = 194 g/mol) is NOT correct?
   a. Four moles of caffeine have a mass of 776 g.
   b. The simplest formula for caffeine is $C_8H_{10}O_2N_4$.
   c. Caffeine contains 28.9% nitrogen.
   d. One mole of caffeine has 6.02×10^{24} hydrogen atoms.

9. How many selenium atoms are required to have the same mass as 126 atoms of sulfur?
   a. $\dfrac{126 \times 32.06}{78.96}$　　b. $\dfrac{126 \times 78.96}{32.06}$
   c. $\dfrac{32.06}{126 \times 78.96}$　　d. $\dfrac{78.96}{126 \times 32.06}$

10. The molecular formula of a substance
   a. is sometimes equal to its simplest formula.
   b. is always a whole number multiple of its simplest formula.
   c. indicates the exact number and the identities of the atoms that make up a molecule.
   d. has the same % composition as that of its simplest formula.
   e. a, b, and c are true.
   f. a, b, c, and d are true.

B. Fill in the blanks:

1. Consider a 5.871 g sample of pure nickel metal.

______________ a. How many moles of nickel are in this sample?

______________ b. How many atoms of nickel are in this sample?

______________ c. What is the ratio of nickel atoms to silver atoms in 5.781 g of nickel and 0.0108 g of silver?

2. Consider the balanced equation for the reaction in which xenon hexafluoride reacts with water forming xenon, oxygen and hydrogen fluoride gases.

$$2\,XeF_6\,(g) + 6\,H_2O\,(\ell) \rightarrow 2\,Xe\,(g) + 3\,O_2\,(g) + 12\,HF\,(g)$$

In an experiment, when 5.0 mol of xenon hexafluoride are made to react with an excess of water, 4.0 moles of xenon are obtained.

______________ a. What is the theoretical yield (in moles) for Xe when 5.0 moles of XeF_6 react?

______________ b. What is the theoretical yield (in grams) for oxygen when 5.0 moles of XeF_6 react?

______________ c. What is the percent yield of Xe in the experiment described above?

C. Problems: Consider the element zinc (Zn).

1. If zinc was designated to have an atomic mass of 100.0 amu, what would the atomic mass of Si be?

2. How many atoms would there be in 1.00 g of zinc? How many moles are there in 3.48 g of zinc? What is the mass of two million atoms of zinc?

3. Zinc has two isotopes. Zn-64 has an atomic mass of 63.9292 amu and Zn-72 has an atomic mass of 71.9278 amu. The average atomic mass for zinc is 65.38 amu. Calculate the abundance, in percent, of Zn-64.

Consider the molecule cyclohexene, which contains only hydrogen and carbon atoms.

4. When a sample is burned in oxygen, 4.822 g of CO_2 and 1.650 g of H_2O are obtained. What is its simplest formula?

5. Calculate the mass percent of carbon and hydrogen in cyclohexene.

6. How many grams of carbon would you obtain from 3.87 g of sample?

7. The molar mass of cyclohexene is 82.10 g/mol. What is its molecular formula?

8. Write and balance the equation for the reaction between liquid cyclohexene and oxygen forming carbon dioxide and water.

Consider the reaction

$$Mg_3N_2\ (s) + H_2O\ (\ell) \rightarrow Mg(OH)_2\ (s) + NH_3\ (g)$$

9. Balance the equation and name each compound.

10. How many moles of $Mg(OH)_2$ are produced from 0.319 mol of Mg_3N_2?

11. How many grams of water are necessary to produce 4.39 mol of NH_3?

12. If 12.48 g of $Mg(OH)_2$ are formed, how many grams of NH_3 are produced?

13. Start with 2.95 g of magnesium nitride and 1.500 g of water.
 a. What is the limiting reactant?

 b. How many grams of magnesium hydroxide can be theoretically obtained?

 c. If only 2.009 g of magnesium hydroxide are obtained, what is the percent yield of the reaction?

ANSWERS

Exercises:

(E1) 72 amu **(E2)** 30 amu **(E3)** 28.1 amu **(E4)** 1.245×10^{23} C atoms
(E5) 69.00 amu **(E6)** 132.14 g/mol **(E7)** 133.12 g/mol **(E8)** 207.3 g
(E9) 0.07998 mol **(E10)** 83.87% C; 11.99% H; 4.14% O **(E11)** CCl_2F_2 ; 31.43 g
(E12) SNa_2O_4 **(E13)** CCl_2O **(E14)** CO_2H_2 **(E15)** $C_2O_2H_6$
(E16) $2\,Cr\ (s) + 3\,S\ (s) \rightarrow Cr_2S_3\ (s)$ **(E17)** $4\,Bi\ (s) + 3\,O_2\ (g) \rightarrow 2\,Bi_2O_3\ (s)$
(E18) 2.64 mol **(E19)** $N_2O_3\ (g) + H_2O\ (\ell) \rightarrow 2\,HNO_2\ (aq)$; 82.2g; 15.7 mL
(E20) $4\,Al\ (s) + 3\,PbO_2\ (s) \rightarrow 2\,Al_2O_3\ (s) + 3\,Pb\ (s)$; 2.113 g
(E21) 8.258 g; H_2S; NH_3; 2.708 g
(E22) $2\,C\ (s) + 3\,H_2\ (g) \rightarrow C_2H_6\ (g)$; 1.774 g; 94.1%

Self-Test

A. Multiple Choice:

1. c **2.** d **3.** c **4.** d **5.** c **6.** d **7.** a **8.** b **9.** a **10.** f

B. Fill in the blanks:

1. a. 0.100 **b.** 6.022×10^{22} **c.** $1.00 \times 10^{3} : 1$
2. a. 5.0. **b.** 2.4×10^{2} **c.** $8.0 \times 10^{1}\%$

C. Problems:

1. 42.97 amu
2. 9.20×10^{21} atoms; 0.0532; 2.17×10^{-16} g
3. 81.9%
4. C_3H_5
5. 87.6% C, 12.4% H
6. 3.39 g
7. C_6H_{10}
8. $2\,C_6H_{10}\,(\ell) + 17\,O_2\,(g) \rightarrow 12\,CO_2\,(g) + 10\,H_2O\,(\ell)$
9. $Mg_3N_2\,(s) + 6\,H_2O\,(\ell) \rightarrow 3\,Mg(OH)_2\,(s) + 2\,NH_3\,(g)$ Mg_3N_2 = magnesium nitride, H_2O = water $Mg(OH)_2$ = magnesium hydroxide NH_3 = ammonia
10. 0.957 mol
11. 237 g
12. 2.430 g
13. a. H_2O b. 2.428 g c. 82.74%